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ABSTRACT

The purpose of this study was to apply the theory of person-environment fit in assessing student well-being in a university computer room. Subjects were 12 students enrolled in a computer literacy course. Their learning behavior and well-being were evaluated on the basis of three symptoms of video display terminal stress usually found in the workplace: visual stress, musculo-skeletal stress, and psychological stress. Environmental contributors to these forms of computer stress were assessed by two techniques: (1) objective observation such as measuring the height of keyboards above the floor; and (2) rational application of established knowledge, i.e., comparing measurements with ergonomic recommendations in the human factors literature. Relevant information from the personalogical dimension was collected via interviews. Preliminary findings suggest all three areas investigated revealed real problems: screens with sharply visible letters were not often available and all screens had reflective glare. The learning stations were cramped and could not be easily moved as security devices were attached with permanent glue. However, students were seldom critical; there is some support in the person-environment fit literature for the idea that the learner role may cause students to believe their learning experiences are organized in the best way possible, or that situations are permanent and cannot be improved. A preventive ergonomics approach is suggested which would sensitize students (and others) to the issues of daily work with computers. A list of references is provided. (JB)

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Learner-Environment Fit:

University Students in a Computer Room

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Abstract

The theory of person-environment fit predicts unhealthy strain caused by a mismatch between factors external to the individual and those that are internal. In the study reported here, the theory of person-environment fit was applied to assess student well-being in a university computer room. A qualitative approach was chosen for this study and a conceptual framework was constructed using Miles and Huberman's technique (1984). A script of questions and probes was prepared from the conceptual framework. Twelve volunteers from a computer literacy course were interviewed. Both objective and subjective data about physical and psychosocial stressors were obtained. Some insights into learner-environment fit are already available, although the results reported here must be regarded as preliminary. Early data cuts suggest educational computing tasks, while less frequent and of shorter duration, may be more intense than pink collar VDT work. Denial or repression may have been a part of the student view in accepting complexity. These defence mechanisms may also indicate a learner role effect which explains student reactions to visual and musculo-skeletal stressors. Better understanding of learner-environment relations is being developed through monitoring interventions such as teaching students how to reduce computer stress.

Learner-Environment Fit:

University Students in a Computer Room

Research on human behavior in work situations has generated a theory describing the relationship of people and their surroundings (Harrison, 1978; Kasl, 1978, p. 33-35; Kulka, 1979). The theory of person-environment fit predicts unhealthy strain caused by a mismatch between factors external to the individual and those that are internal. Stressors may be physical or psychosocial. Each can function objectively or subjectively, operating independently or dependently of the person's perceptions as shown in Figure 1.

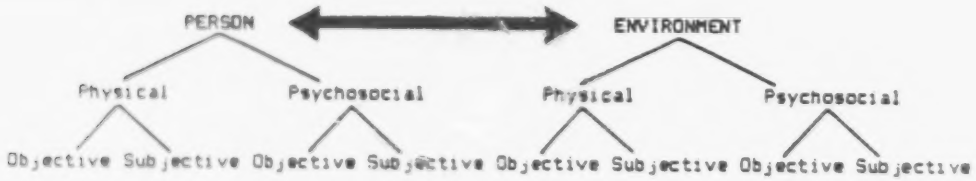

Figure 1. Diagram of person-environment fit components.

The person-environment fit theory is advocated for the study of Visual Display Terminal (VDT) work (National Research Council, 1983, p. 173-193). The goal in that instance is improving the congruence between human characteristics and the computerized workplace. Unhealthy stress is explained as the result of unsuitable environmental conditions created by the rapid implementation of new information technologies. In the study reported here, the theory of person-environment fit was applied to an assessment of student well-being in a university computer room, towards developing better understanding of learner-environment relations in general.

Two separate site analysis studies preceeded the investigation (Yeaman, 1983; 1985). They were rational in nature in that they compared educational computing facilities with a checklist synthesized from standards and guidelines for VDT work. Several physical, objective aspects of the environment appeared inadequate for the students' range of physiological characteristics. The checklist identified lack of adjustment in keyboards and screens; inappropriate chairs, footrests, desk height, leg room and keyboard height; reflective glare from screen and keyboard; and direct glare from bright lights and windows in the field of view. Objectively established psychosocial stressors were the intrusive sounds of voices

and printers and the lack of visual privacy. Based on application of that checklist and informal observations of students, recommendations were made for improving microcomputer learning conditions in both settings.

Student impressions had not been assessed and the strength of the student-environment relationship was not known. An obvious difference between academic and workplace computing is the shorter exposure time of learners. Therefore, it was expected that there would be less objective physical and psychosocial stress and the stressors would be assigned weaker subjective perceptions; that the affect of deficient computing environments upon students would be less than upon workers.

Method

Due to the complexity of the issues, a qualitative approach was chosen for this study. Strong arguments have been made for this mode of investigative thought in the field of educational communication and technology (Kerr & Taylor, 1985). A reductionist and intrusive measure of stress such as before and after levels of catecholamine and adrenocortical excretion would be limited to only producing data on the objective person physical dimension. Quantitative paper and pencil self-report scales were ruled out due to the importance of sample size in epidemiological surveys on VDT work(Helander, Billingsley & Schurick, 1984).

Following informal observations of several academic computing facilities, a conceptual framework was constructed using Miles and Huberman's technique (1984), see Figure 2. It particularly reflects the learner-environment relationship in delineating components for analysis that are both objective and subjective. The dimensions were corroborated by the Wisconsin-NIOSH industrial study conducted by Sauter, Gottlieb, Jones, Dodson & Rohrer (1983).

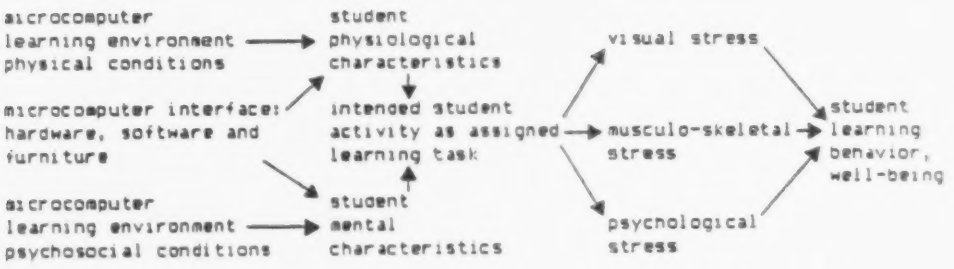

Figure 2. Dimensions of the conceptual framework.

A script of questions and probes was prepared from the conceptual framework. The script was used to conduct structured interviews with university students using the microcomputers in a single computer room. The students reported on the dimensions illustrated in Figure 2.

Because the human factors research literature indicates three predominant symptoms of VDT stress--visual, musculo-skeletal and psychological (National Institute for Occupational Safety and Health, 1981; Sauter et al., 1983)--they were the focal point for evaluation. Both objective and subjective data about stressors were obtained. Objective data included such information as height, weight, corrective eyewear, previous computing experience and time of day each student usually went to the computer room. Subjective data, based on student experiences in the computer room, included such information as feelings of visual and physical discomfort and psychological aspects such as the degree of complexity perceived in completing assignments. Questions about experiences in the computer room preceeded potentially sensitizing questions about feelings of well-being. Regarding the acceptability of verbal reports as data (Nisbett & Wilson, 1977), cautions against confabulation included the acceptance of verbose responses rather than offering the repondents a fixed set of alternative answers (Ericsson & Simon, 1980).

Twelve participants were interviewed. They were all enrolled in a computer literacy course and volunteered to be in the study in exchange for an extra credit incentive offered by their instructor. There were five women and two men from the afternoon section and two women and three men from the evening section of the class. They varied in age from 19 to 35 with 10 students between 19 and 22. None of the interviewees were previously aquainted with the investigator.

The computer room used by the students in this study was originally a small classroom and it had undergone renovation to become a place for academic computing. Briefly, its features were a single door, two rows of suspended fluorescent lights and two unshaded windows. Power strips had been installed and a black workbench erected against three walls. At the time of this investigation, the workbench supported three Apple II+ and two Apple IIe microcomputers, two Okidata dot matrix printers, a Televideo 925, a Lear Siegler ADM-3WU, a DecWriter, a manual typewriter and an electric typewriter.

Individual students working on computer literacy assignments were the primary visitors to the facility and the subjects of this study. Length of use varied from 20 minutes to 8 hours with most students word processing papers or writing programs. They used Magic Window for word processing, Apple BASIC for programming and VisiCalc for spreadsheet exercises. Students from programming classes were the next largest group of people to be found in the room. Other people occasionally present were university clerical workers and professors. Adults and children from the community came in on the evenings and weekends more than any other time. The handful of hacker-like

students on the campus preferred to be with the Commodore 64 in the physics lab. That was the place Apple II software was kept and three were employed in checking it out a few hours each day. There was only one hacker-like student frequenting the computer room at the time of the investigation. Unable to take the Pascal class due to a schedule conflict, he taught himself and then proceeded to create a russian typing tutor so he could master the cyrillic keyboard.

Preliminary results

Visual Stress

Objective

Three of the Apple II+ microcomputers had Amdek color monitors which made text appear fuzzy due to horizontal smear. This was particularly apparent when in the 80 column mode. Screen angle was not adjustable. Brightness, contrast and color controls were concealed behind a door immediately below the screen. The fourth Apple II+ had a an older model Heath Zenith green screen with black level and contrast knobs on the front. The image on this screen intermittently rippled and blurred. Sometimes a waving grid pattern appeared too.

The Apple green screens on the Apple IIe microcomputers presented alphanumeric characters considerably sharper. They were adjustable for tilt by pushing on the top or bottom of the screen. Brightness was controlled by a knob on the side. The contrast knob was on the back and not readily accessible.

All the screens reflected the overhead lights and created reflective glare. Two screens reflected extreme glare from the windows: This was particularly strong due to snow outside four months of the year. At night the windows acted as mirrors, reflecting the fluorescent lights. There were no curtains or shades. Keycaps and chrome security locks created highly contrasting reflective glare at every station.

No one was instructed in adjusting the position of screens to reduce reflective glare and increase visual comfort and efficiency. Nor was anyone told about adjusting screen brightness and contrast to suit personal preference. There were no copyholders and drafts of papers and programs were usually laid flat--which induced off-angle reading.

When working with the microcomputers, the students faced the wall at all times: there was nowhere to look away and focus on distant objects for vision relief. Five of the students interviewed wore glasses and another five wore contact lenses. All of those 10 students were myopic. In addition to being nearsighted, two said they had correction for astigmatism. None of the students reported having

uncorrected visual problems. None were taking tranquilizers, a medication which can produce visual fatigue symptoms through changes in oculomotor functions.

Subjective

Eight students reported visual discomfort such as red, bloodshot, tired eyes. Four students experienced visual discomfort within the first hour of microcomputer use or less. Three more had eye problems within two hours or less.

Only one student thought the screens too bright or too reflective but other students added qualifying statements: "Unless it is a color screen and that bothers me." "The older models." "Not the screen--sometimes the light coming through the windows will cause glare on the screen."

Ten students never adjusted screens for tilt, contrast or brightness. One adjusted tilt, "To see the bottom of the page." One adjusted contrast, "To make it easier to look at." Nearly all students were vague about the location of any accessible screen controls. There was confusion over there function and sometimes denial of their existence. One student mentioned switching to a 40 character line with bigger letters to make the screen easier to read when using the word processor.

Gender differences became apparent when the students were asked about how reading from the screen felt. Men gave short replies such as "Pretty good." "Okay." and "Very comfortable but my eyes get tired." " Women replied: "Sometimes the words are blurry." "I have to read things twice. After a while they run together--sort of blurry." "After a while it becomes fuzzy to look at." "There are different types of screens and sometimes I have to strain to read the dots." "Would like a bigger screen so I could put more on a line." "If proofing, single spacing is difficult to read. I lose part of the text as I'm scrolling along--it's frustrating."

Analysis

The short time for the onset of eyestrain is anomalous. In comparison, a survey of daily VDT users in a large Swedish insurance company resulted in 55% complaints of optical discomfort (Ericsson Information Systems AB, 1983, p. 63). Contrary to expectations these data suggest educational computing tasks, while less frequent and of shorter duration, may be more intense than the pink collar VDT work which is the usual object of investigation. The unsatisfactory quality of some of the screens for reading text may also be a contributing agent.

Student responses were occasionally self-contradictory. Instead of saying they personally experienced a problem, descriptive evidence was provided which indicated a problem. The male responses were unusually brief in these situations but one succinctly illustrates the paradox: "Very comfortable but my eyes get tired."

Musculo-skeletal stress

Objective

Students varied in weight and in height: from 103 to 220 pounds and from 4 feet 11.5 inches to 6 feet 3 inches. These were accommodated by one size fits all microcomputer stations. Some of the microcomputers were positioned right above the steel legs of the workbench that supports the microcomputers and students sat with restricted knee and leg movement. A general indication of insufficient leg space was the scuff marks around the room where the wall had been kicked by students trying to stretch their legs out. The Apple II home row was 30.5 to 31 inches above the floor. This keyboard height caused many students to sharply bend their elbows and wrists and is higher than any trade union guideline for workstation design, see Ericsson Information Systems AB, (1983, p. 146). The Apple II keyboards were not adjustable or moveable in any way. No footrests were available for shorter students. The chairs had arms attached and were not at all adjustable.

Subjective

On the subjective level, 8 of the 12 reported at least some postural discomfort in either neck, hand, wrist, fingers, shoulders, back or a combination of locations. However most apparently attributed this to what they were doing not, to the furniture. For example, only two people said the chairs were uncomfortable. Complaints of bruised knees were made by one man and by one woman in reference to the steel support legs. Without prompting, three students commented on the lack of copyholders--which they had learned to use in high school typing classes--and said they propped up pages with a book.

Analysis

There was some physical misfit between the objective person and the objective environment because one size does not fit all. This is particularly important to consider when assessing microcomputer learning stations as the equipment severely constrains posture, as opposed to working with print materials that can be moved around. In reference to the steel struts supporting the work surface, the poor positioning of the microcomputers made matters worse. They could not be easily moved as the security devices were attached with permanent glue. However, using those particular microcomputer stations does contain an element of minor hazard. It is revealing that the students' subjective views seldom identified physical aspects of the

environment for improvement. With the exception of the students with bruised knees, they took responsibility for any musculo-skeletal discomfort experienced upon themselves.

Psychological Stress

Objective

New technology is often viewed as too complicated and difficult to comprehend. In this situation, the learners were required to master small details to make computing work for them. These fine points were often limitations imposed by the software and hardware and irrelevant to the larger learning intended.

Subjective

During their interviews 11 of the students never directly admitted that the computers and the computing tasks might be too complex. Nevertheless, a poor person-environment fit is likely since nine reported incidents when they could tell that other students were upset or annoyed. Students were unable to make their programs run. They lost termpapers and programs in the microcomputers and were unable to save or retrieve work which took hours to type in. They reacted by muttering, exclaiming out loud, banging a fist on the table and crumpling or tearing up their paper print out.

Analysis

Denial or repression may have been a part of the student view in accepting complexity. These defence mechanisms may also indicate a learner role effect which would aid in explaining the student reactions to visual and musculo-skeletal stressors. Denial or repression are also suggested by the National Research Council (1983, p. 177) to account for a subjective-objective fit relationship "weakened by a person's subjective distortions."

Six students took responsibility for any problems on themselves with statements such as: "If you have the time to put in--basically--no, they're not too complex." "You must take time to get acquainted. You just can't sit down and do it." "I'm not a brain when it comes to computers. It's a basic computing class--could be more complicated." A student moderated his response by identifying complexity brought about by technological transition: "I'm used to Radio Shack computers so I find it hard sometimes."

Only one student said yes, that the computers and computing tasks were too complex. She placed the responsibility outside of herself by identifying subtle differences between operating the Apple IIe and Apple II+ microcomputers and the inconsistency of software commands for performing the same function.

Discussion

Student learning behavior and well-being were evaluated on the basis of three criteria. These were the symptoms of VDT stress usually found in the work place: visual stress, musculo-skeletal stress and psychological stress. Environmental contributors to these forms of computer stress were assessed by two techniques. The first was objective observation such as measuring the height of keyboards above the floor. The second was rational application of established knowledge such as comparing that measurement with ergonomic recommendations in the human factors literature. Relevant information from the personalogical dimension was collected through interviews. For instance, self reports of physical measurements showed the facility was used by people with a wide range of characteristics. Responses to questions and probes regarding specific stress issues and instances were collected. Analysis has begun and the results of several cuts of the data are reported here.

How computer learning experiences are viewed by students is enigmatic but a position is being built. There is real evidence of the three types of computer stress: student computing activities may be far more stressful than the experience of computer workers. Unlike professionals, the students have high pressure to perform, low control over their tasks, less autonomy and less support in terms of efficient facilities. All three areas investigated revealed real problems. Screens with sharply visible letters and numbers were not often available and all screens had reflective glare. The learning stations were cramped like cockpits in military airplanes. The hands on aspect of computing in demanding attention to trivia was an impediment to the more important, conceptual learning intended. Despite providing supporting evidence for each from of computer stress, students were seldom critical. In favoring satisfaction over dissatisfaction, their statements perhaps reflected more what students would prefer to think about their educational experiences.

Personal characteristics cause individuals to reflect person-environment fit differently and so may group characteristics. Workers with more creative, less repetitive VDT jobs and higher socioeconomic status voice less complaints (Smith et al., 1981, p.397). This white collar group aspect might provide more meaningful comparisons when examining university students: a learner role effect. Student perceptions may be muted by their role: perhaps students tend to be more accepting of what they receive becauses instructors are authorities. The learner role may cause students to believe their learning experiences are set up in the best way possible; that situations are permanent and cannot be improved. There is some support in the person-environment fit literature for this. A study of person-environment fit conducted with 2,020 high school students by French, Rodgers & Cobb (1974) has been re-analyzed by Kulka (1976). Poorer fit was reported by girls than boys, which also lends credence to the gender differences suggested here. Kulka also identified a tendency

for goodness of fit to increase for older cohorts. University students may extend that and cover up the occurrence of misfit.

Conclusion

Some insights into learner-environment fit are already available, although the results reported here must be regarded as preliminary. They are the consequences of gathering rich, complex data not yet fully analyzed. Better understanding is being developed through ongoing observations and informal questioning of students. Monitoring the effects of intervention such as teaching students how to reduce computer stress are part of this.

A preventive ergonomics approach is taken which has several components, including sensitization to the issues of daily work with computers. These are readily demonstrable as the computer room has not been modified except for conversion to all Apple IIe microcomputer equipment and Appleworks integrated software. Some examples follow: Students are shown how to adjust screens to match contrast and brightness to their personal preference and how to tilt screens to minimize reflective glare. They are encouraged to get up, walk around and engage in stretching exercises and not stay rigid in one seat. Frequent rest breaks are also suggested.

Psychosocial dimensions are handled in a similar way. Caporael identifies two important components in learning to use a computer (1985, p. 187-188): trial and error learning and computing as a social activity. Trial and error learning is reduced by several strategies: Students are encouraged to save their work every 15 minutes at least to avoid accidental loss. Recipe sheets are prepared with instructional design principles to guide beginners through the basic steps of using a word processor, a spreadsheet and a database. New strategies have also been adopted to reinforce the social transfer of information: There are more large screen demonstrations in class time. There are also more orientation labs as part of class. Students are encouraged to work together on class projects in twos or threes. Above all, students are encouraged to take responsibility for their learning upon themselves and practice Ellis' philosophy (1978):

> I feel determined to strive to use whatever power I have to change the unpleasant stresses of life that I can change, to dislike but realistically accept those that I cannot change, and to have the wisdom to know the difference between the two. (p.203).

Ergonomic recommendations for business computing facilities have been applied towards the objective assessment of microcomputer learning environments (Yeaman, 1983, 1985) but subjective dimensions also need to be considered in research on educational computing. Students' reported feelings need to be checked against what they perceive happening to other students and contrasted with objective dimensions of the conceptual model, shown in Figure 2, through direct

observation. The application of person-environment fit may be useful in developing guidelines for the improvement of computer learning facilities. Just as computer learning experiences should increase student well-being and learning performance, so should any learning experiences, and further analysis of learner-environment relations may provide a fruitful theory for that interaction.

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